

# **Entangled Edge Channels in the Quantum Hall Effect**

**Carlo Beenakker**

*Instituut-Lorentz, Universiteit Leiden, Netherlands*

The controlled production and detection of entangled particles is the first step on the road towards quantum information processing. In optics this step was taken long ago, but in the solid state it remains an experimental challenge. A variety of methods to entangle electrons have been proposed, based on quite different physical mechanisms. A common starting point is a spin-singlet electron pair produced by interactions, such as the Coulomb interaction in a quantum dot or the pairing interaction in a superconductor.

We have discovered an altogether different, interaction-free source of entangled quasiparticles in the solid state. The entanglement is not between electron pairs but between electron-hole pairs in the Fermi sea. The entanglement and spatial separation are realized purely by single-particle elastic scattering at a tunnel barrier in a two-channel conductor. As a possible realization we propose edge channel transport in the quantum Hall effect, which makes use of existing technology.

There is a remarkable contrast with quantum optics, where entanglement can not be created by linear optics if the photon source is in local thermal equilibrium. In that case one needs to start from a squeezed state or a Fock state if one wants to produce the entanglement by means of a beam splitter. The existence of a Fermi sea is what allows one to overcome this obstacle in the electronic case.